Summary

English version

Laboratory : ICube - UMR 7357

Institution : INSA Strasbourg

Research Team : CSIP (Design, Information Systems & Inventive Processes)
- Website : https:// icube-csip.unistra.fr/

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Working language: English or French

PhD Title :

Contribution of inventive design for developing new meta-materials for acoustic and vibration insulation

Keywords:

Meta-materials, Acoustic, Inventive Design, TRIZ, Data Mining, Knowledge extraction, Innovation,

PhD Subject :

Efficient development of meta-materials for acoustic and vibration insulation: lightweight and robust, these materials main feature is to control low and medium frequency noise and vibration in the new generation car structures. They will take the form of insulation panels of the structure or incorporated components. They are artificial structures or materials composed of different elements arranged in a precise layout, and the dimension of which is lower than the wavelength that it is expected to be filtered. These new materials will stop the propagation of acoustic and vibratory waves within predefined frequency range. They must have a high absorbency in the low frequencies and provide a controlled structural damping, in order to allow a perfect isolation of noises and

vibrations. We are interested in local resonance structures operating in sonic conditions (regimes). These structures appear macroscopic (millimeter) for low frequencies.

The design process of these materials, which involves repeated sequences of model generation, simulation, experimentation and optimization, is high time consuming. We aim at accelerating this process through the development of new tools exploiting the use of data analysis and inventive design techniques. The approach and tools can be applied more generally to similar problems.

In terms of economic impact, on the one hand, the material by integrating several properties will allow removing other structural elements present to perform these functions and, on the other hand, the expected improvement in efficiency of the design process should reduce the number of simulation and physical experiments, which can be very expensive.

Research Work Plan

This work will be organized in different steps:

- Characterization of the expected performance of the material and of the design process.
- State of the art and detailed problematic. The purpose of this part is to define the detailed problems and structure them through the bibliography and the data of past experiences. Inventive design problem structuring will be used to analyze and structure knowledge.
- As previous step analysis defines the problems, one will be able to build solution principles and define the numerical model(s) to be realized.
- Numerical modeling, optimization and improvements. After modeling and optimization of the digital model, we will seek to improve the performance obtained solutions. It is in this phase that we will use data analysis tools for inventive design and evaluate them.
- Meta-material production and physical experimentation.
- Evaluation of both the material performances and the contributions of inventive design tools to the research process.

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Chinese version

博士课题：

发明设计原理对开发用于隔音和隔振的新型超材料的应用研究

关键词：

超材料，声学，创新设计，TRIZ，数据挖掘，知识提取，创新，

课题综述：

隔音和隔振的新型超材料高效开发：这些材料的主要特点是重量轻，坚固耐用。这些特点可以用来控制新一代汽车结构中的低，中频噪声和振动。在结构上，他们将采取结构或合并组件的绝缘板的形式。它们是由不同元素组成的人造结构或材料，它们以精确的布局排列，其维度低于预计要过滤的波长。这些新材料将阻止声波和振动波在预定频率范围内传播。要求必须在低频时具有高吸收性并提供可控的结构阻尼，以便完美隔离噪音和振动。在这项研究中，我们感兴趣的是在声波条件下工作的局部共振结构（状态）。以及这些结构对于低频率的宏观表现（毫米）。

这些材料的设计过程涉及模型生成，模拟，实验和优化的重复序列，耗时长。我们的目的是通过开发利用数据分析和创造性设计技术的新工具来加速这一过程，使这种方法和工具可以更普遍地应用于类似的问题。

就经济影响而言，一方面，通过集成多个属性，使材料能够在去除一些结构元素的条件下执行这些功能，另一方面，设计过程效率的预期提高应该减少昂贵的模拟数量和物理实验。

研究工作计划

包括以下步骤：

•表征材料和设计过程的预期性能。
•文献综述。这部分的目的是通过文献和过去经验的数据来确定并组织具体问题。使用创造性设计问题构造来分析和构建知识。

•由于前面的步骤分析定义了问题，因此可以构建解决方案原则并定义要实现的数字模型。
•数学建模，优化和改进。在对数学模型进行建模和优化之后，我们将努力提高获得的解决方案的性能。在这个阶段，我们将使用数据分析工具进行创造性设计并对其进行评估。
•超材料生产和物理实验。
•评估材料性能以及创新设计工具对研究过程的贡献。

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